

# The migration and movement patterns of Atlantic herring; an anchor tagging project in the Gulf of Maine and southern New England

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## Project Description

Atlantic herring (*Clupea harrengus*) is one of the most biologically and economically important species in the western Atlantic. Herring are oceanic plankton-feeding fish that occur in large schools, inhabiting coastal and continental shelf waters from Labrador to Cape Hatteras. Adults (age 3+) migrate south from summer/fall



spawning grounds in the Gulf of Maine to winter off southern New England and the Mid-Atlantic states. Important commercial fisheries for juvenile herring (ages 1 to 2) existed from the 19<sup>th</sup> century through the 1980's along the coasts of Maine and New Brunswick. The development of large-scale fisheries for adult herring is comparatively recent, primarily occurring seasonally in the Gulf of Maine, on Georges Bank, and in southern New England waters. In addition to their commercial value, herring are an important food source for many species of fish, mammals, and sea birds. Commercial landings are currently around 200 million pounds of which 60 percent goes to the lobster bait market and 40 percent to canneries and freezer plants.

There have been several Atlantic herring tagging projects in the past, however the herring fishery has changed significantly since the last tagging effort in US waters (1970-1982). Mobile gear (purse seine and mid water trawl vessels) fishing pressure on the inshore stock component has increased, herring have largely moved away from nearshore coastal waters, and the Georges Bank stock component has recovered from its collapse of the 1970's.

Traditionally, two stocks of herring have been recognized in the Gulf of Maine region. Within each of these stocks are a presumed number of discrete spawning units. However, the US stocks are assessed together as one unit for management purposes. A tagging project was designed by the Maine Department of Marine Resources (DMR) in 2001 to identify stock discreteness, exploitation rates and reevaluate quota allocation in order to address research objectives proposed by the New England Fishery Management Council



and the Atlantic States Marine Fisheries Commission. The original project was designed using coded wire tags but, due to problems with the detection units, this method was abandoned in favor of anchor tags at the end of 2002 (for a more complete description of the decision process please refer to the 2002 annual report). With the project

infrastructure in place and the experience gained over the preceding two field seasons, activities in 2003 centered on tagging and releasing as many herring as possible in southern New England and the Gulf of Maine.

## **Methods**

### ***Identification of Tagging and Recovery Strata***

Several tagging strategies designed to identify stock discreteness and spawning site fidelity were attempted between 2001 and 2002. During that time the study focused exclusively on tagging of spawning aggregations. This approach eliminated flexibility and resulted in difficulty and sometimes a total inability to obtain herring. Based on these preliminary trials, it was determined that future tagging should occur over broader groupings of space and time thereby increasing project flexibility. This adopted strategy allowed a more opportunistic approach to tagging in 2003 while still classifying tagged herring into meaningful groups based on behavior and location.

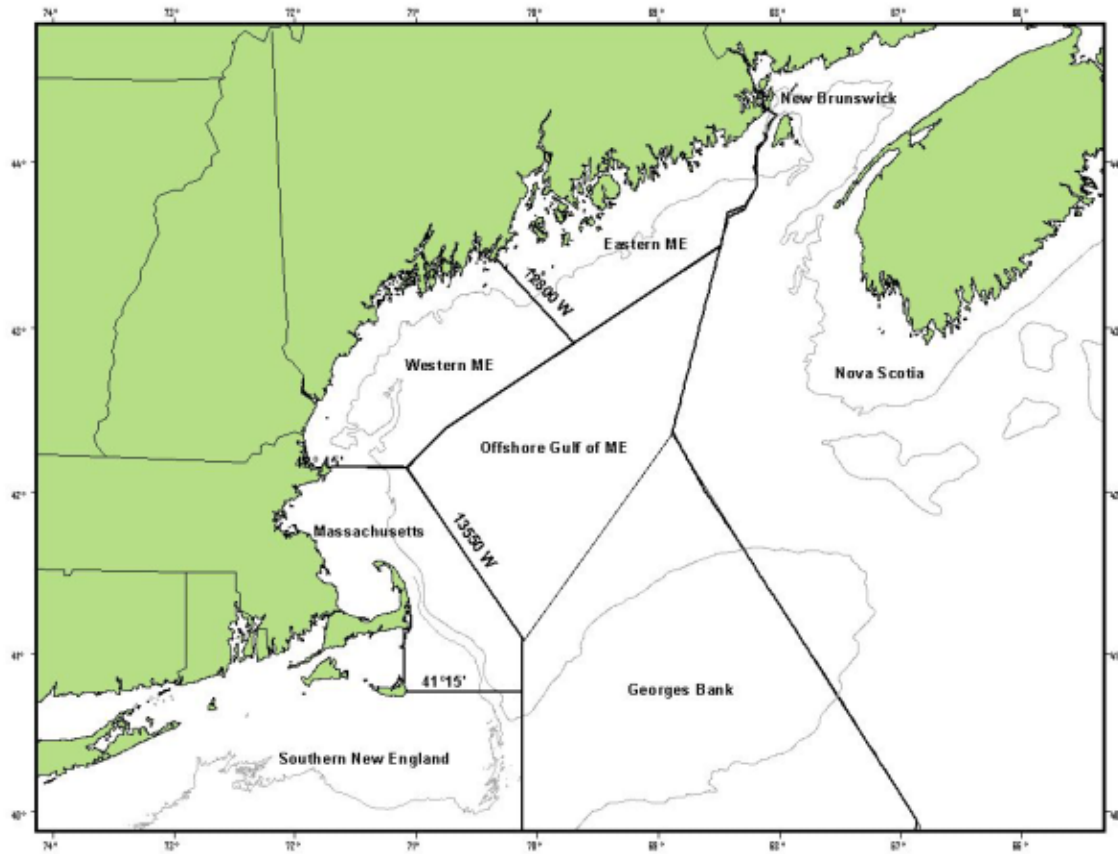
Atlantic herring exhibit annual coast-wide migration patterns that range from Canadian waters to the mid-Atlantic. Therefore, tagging events and tag returns have to be categorized in the context of space and time.

Spatial strata include the geographic areas where tagging events occur and also encompass the areas to which returns are attributed. The following spatial strata were identified as potential tagging and/or recovery areas for the Atlantic herring tagging project.

#### **Geographic Areas (spatial context):**

1. Canada
  - A. New Brunswick (NB)
  - B. Nova Scotia (NS)
2. Gulf of Maine
  - C. Eastern Gulf of Maine (EGOM)
  - D. Western Gulf of Maine (WGOM)
  - E. Massachusetts (MA)
  - F. Offshore Gulf of Maine (OGOM)
3. Georges Bank (GB)
4. Southern New England (SNE)

**Figure 1: Spatial strata identified for the Atlantic herring tagging project**



The temporal context of the tagging and recovery events is also important. Atlantic herring exhibit distinct behavioral patterns at different times of the year that must be considered in the project design and analysis. The groupings outlined below are largely based on tagging work done by DMR in the 1970s and 1980s.

**Seasonal Groupings (temporal context):**

- |                                   |                   |
|-----------------------------------|-------------------|
| 1. Spring migration (SM):         | April-June        |
| 2. Summer feeding/spawning (SFS): | July-October      |
| 3. Fall migration (FM):           | November-December |
| 4. Winter feeding (WF):           | January-March     |

It is important to recognize that these strata are designed to define general seasonal patterns. For example, the SFS stratum does not specifically represent spawning times for each discrete group of herring, but encompasses the entire range of spawning events.

## ***Field Methods***

Tagging events in 2003 occurred on both commercial purse seine vessels and contracted mid-water trawl vessels. Tagging that took place on commercial purse seine vessels used a modified xactix box and submersible pump designed to supply a constant flow of fresh sea water. An aquarium codend, specifically built for this project was used for chartered trips aboard mid-water trawl vessels. For a complete description of these methods please reference the 2002 annual report.



## ***Returns***

In order to encourage tag returns, an annual lottery with a reward of \$1,000 was established. Reward posters, tag return forms, and brief project descriptions were sent out to industry members informing them of this program. Reward posters were also distributed by DMR personnel involved with the project to fishery related businesses and other waterfront locations. The winning name will be drawn at the Annual Fisherman's Forum from a pool of all individuals who returned tags in 2003.

## **Results**

### ***Tagging Events***

The total number of herring tagged in 2003 was 19,808. Fish were tagged in 3 different spatial strata and 2 different temporal strata.

**Table 1: Number of herring tagged by spatial and temporal strata**

SPATIAL STRATA	TEMPORAL STRATA		
	SFS	SM	TOTAL
EGOM	7075		7075
SNE		4535	4535
WGOM	7873	325	8198
TOTAL	14948	4860	19808

Tagging did not occur in every spatial and temporal stratum for many reasons. For example, logistic and financial restrictions did not allow for tagging on Georges Bank or in Nova Scotia in 2003. The timing of tagging events is also linked to the behavior of the herring, therefore making tagging in every spatial stratum during every temporal stratum impractical or impossible. The following table identifies the target spatial and temporal strata for tagging efforts and their priority ranking.

**Table 2: Target areas and times for tagging efforts**

SPATIAL STRATA	TEMPORAL STRATA				
	SM	SFS	FM	WF	PRIORITY
<b>EGOM</b>		• #			HIGH
<b>WGOM</b>		• #			HIGH
<b>MA</b>	• #		• #		LOW
<b>OGOM</b>	• #		• #		LOW
<b>GB</b>		• #			HIGH
<b>SNE</b>	•			• #	HIGH#
<b>NB*</b>		• #			MEDIUM
<b>NS*</b>		• #			MEDIUM

\* - The Canadian Department of Fisheries and Oceans is currently conducting a weir tagging study in New Brunswick. At present, there is no herring tagging effort on the fishing grounds off Nova Scotia.

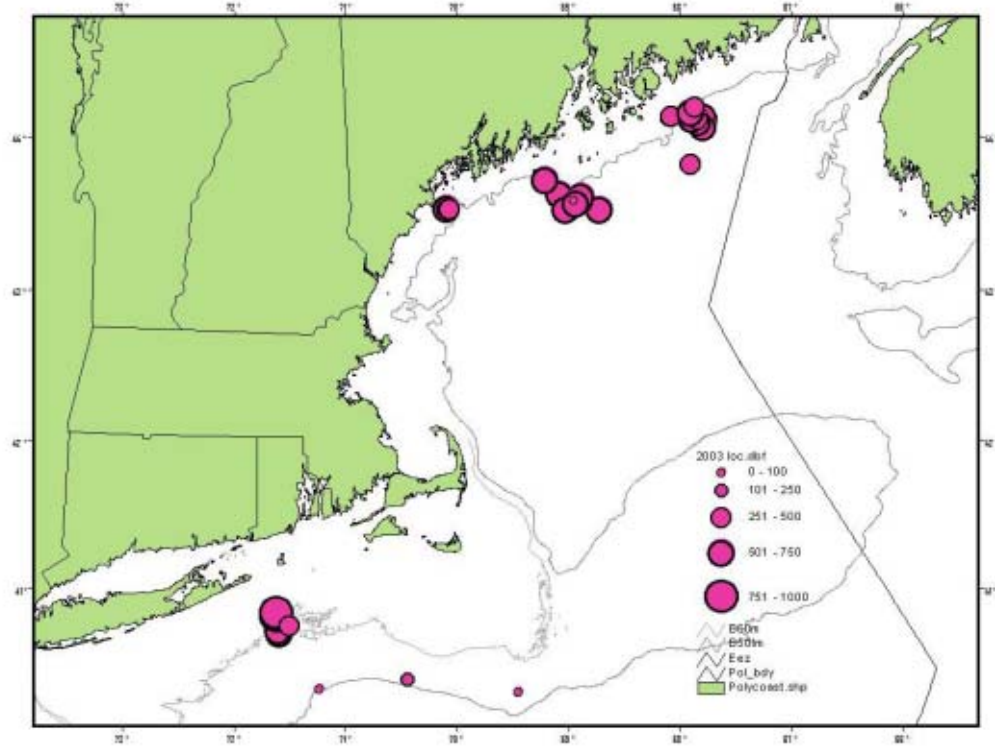
The first field-tagging event of 2003 occurred in late April off of Block Island, RI. Tagging trips then started again in June and continued through October in the Gulf Of Maine. The following table shows the number and type of all tagging trips taken in 2003.

**Table 3: Number and type of tagging trips**

TRIP TYPE	NO. TRIPS
Commercial Trips (purse seine vessels)	12
Chartered Trips (mid-water trawl vessels)	14
Trips w/no fish	5
<b>TOTAL</b>	<b>31</b>

A total of 7,924 herring were tagged and released aboard purse seine vessels with an average of 660 herring tagged per trip. Aboard mid-water trawl vessels 11,884 herring were tagged and released for an average of 849 per trip. The following map shows the location of each set (some tagging trips had as many as six sets) with the markers representing the number of herring tagged per set.

**Figure 2: Location of tagging sets in 2003**



Representative samples were taken on each tagging trip in order to categorize the size and maturity of the captured herring. Please refer to Appendix 1 for length frequency plots by trip (samples were not taken for trips: 6,7 and 8).

### ***Tag Returns***

Forty-five tags were returned during 2003 and an additional 4 tags were returned in January 2004 from fish tagged in 2003. The following table shows the spatial and temporal strata of the tag applications and returns.

**Table 4: Tagging and recapture times and locations**

TAGGING		RECAPTURE													
		SM						SFS						FM	
		NS		NB		EGOM		WGOM		UNK		NS		NB	
SM	WGOM	1		1		2		1		1		2		1	
	SNE	1		4		1		2		1		2		1	
SFS	EGOM	2		3		14		3		1		1		1	
	WGOM	2		2		2		2		2		1		1	

The longest distance traveled by a tagged herring was 565 nautical miles (measurement represents a straight line between the point of release and the point of recovery) from Block Island, RI to Scots Bay, NS. Time at large for the returns ranged from 1 day to



244 days with an average of 85 days. Appendix 2 contains maps showing tag returns as a function of temporal return strata.



### **Long Term Project Goals:**

The Atlantic herring anchor tagging project is designed to be a long-term, comprehensive program. Data collected over the next decade should contribute to our understanding of migration and movement patterns, spawning site fidelity and stock intermixing. Immediate project plans include repeating tagging efforts in southern New England during the winter-feeding and spring

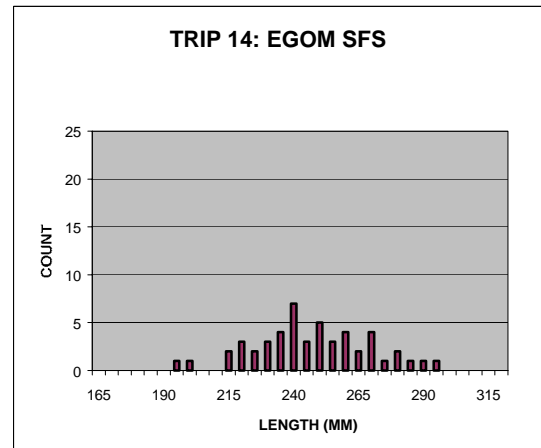
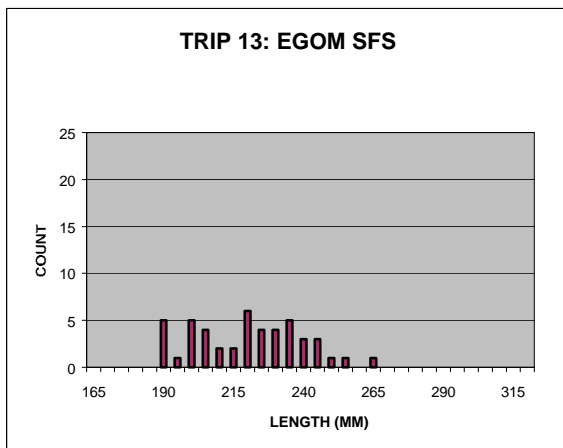
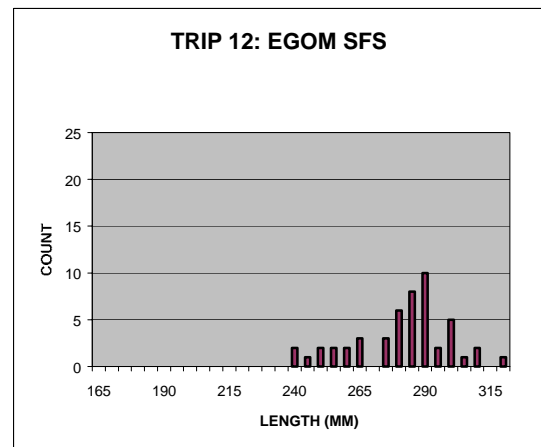
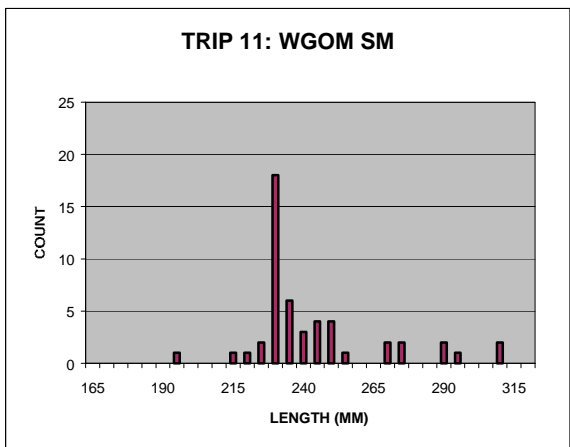
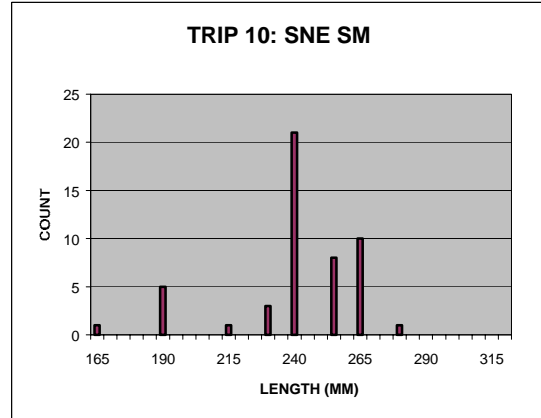
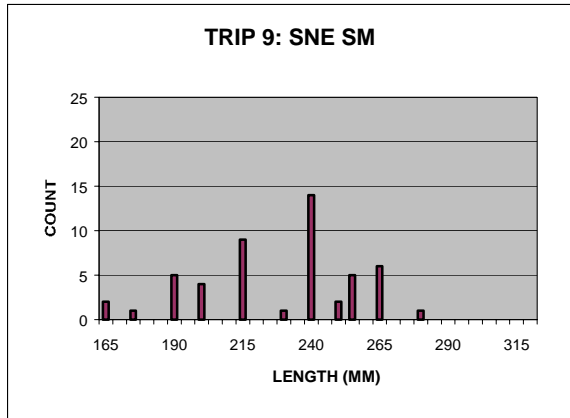
migration strata and tagging in the Gulf of Maine during the summer feeding/spawning stratum. Additional plans include securing funding for tagging herring in the summer and fall on Georges Bank. Cooperative efforts between the DMR and DFO, including tag retention studies and data pooling will continue in 2004. We anticipate conducting a collaborative effort in the summer of 2004 to tag herring in Scots Bay and on German Bank, NS.

The most significant future challenge to the Atlantic herring tagging project is securing consistent funding. In 2003, the tagging project was funded almost exclusively by the herring industry through in-kind contributions and cash donations. Failure to secure grant money in 2004 will jeopardize the continuation of the project and eliminate any possibility of expanding tagging to Georges Bank.

### **Acknowledgements:**

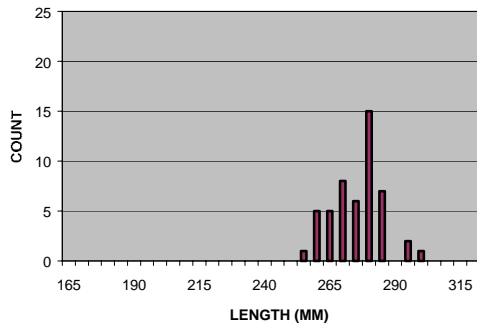
The success experienced by the Atlantic herring project in 2003 was due in great part to the continued commitment and support of the herring industry. We are extremely grateful for the willing cooperation of the captains and crews of the F/V Jennifer and Emily, F/V Ocean Venture, F/V Thunder Bay, F/V Western Sea and F/V Western Wave. Their contributions ranged from allowing us to accompany them on commercial fishing trips, conducting contract work during non-fishing days, and providing insight on herring movement and behavior. We would like to thank the East Coast Pelagics Association, Connors Brothers, Cape Seafoods and Stinsons for their financial contributions. We also thank the Gulf of Maine Research Institute for allowing tagging to occur during the fisheries independent acoustic survey.

**Appendix 1: Length frequency charts by trip number**  
(An abbreviation key can be found on the last page of this report)

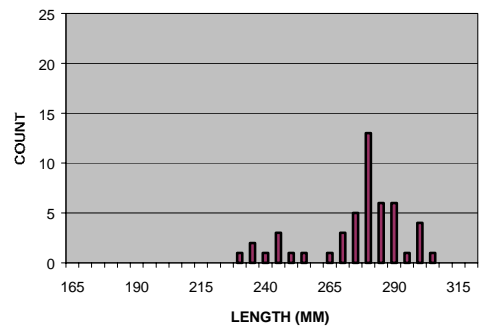




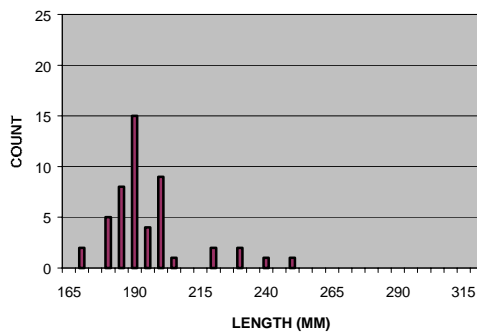
**TRIP 15: WGOM SFS**



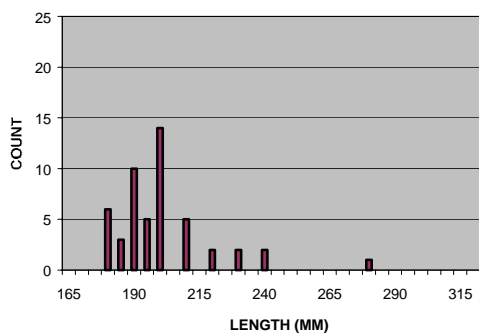
**TRIP 16: WGOM SFS**



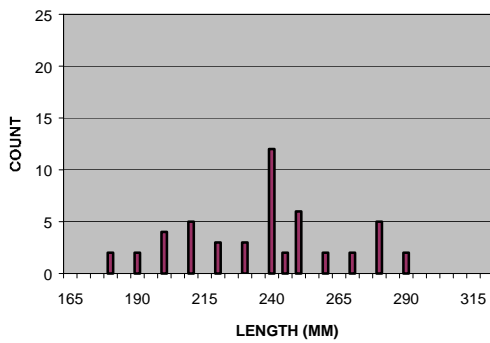
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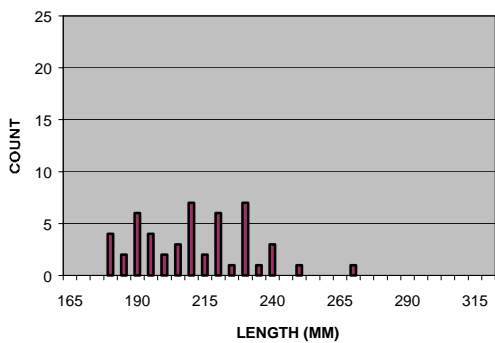
**TRIP 18: EGOM SFS**



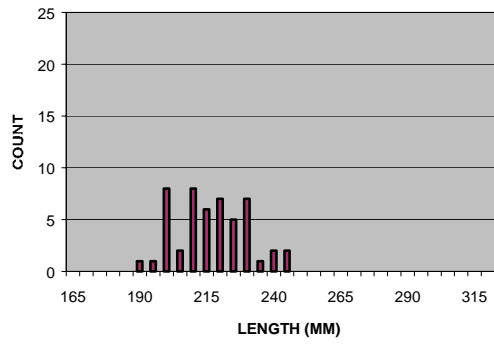
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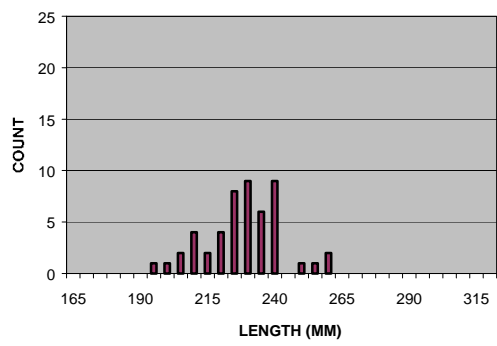
**TRIP 20: EGOM SFS**



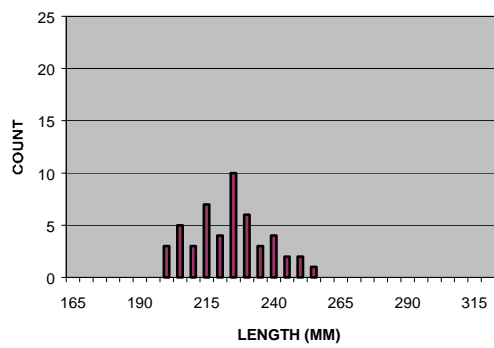
TRIP 21: WGOM SFS



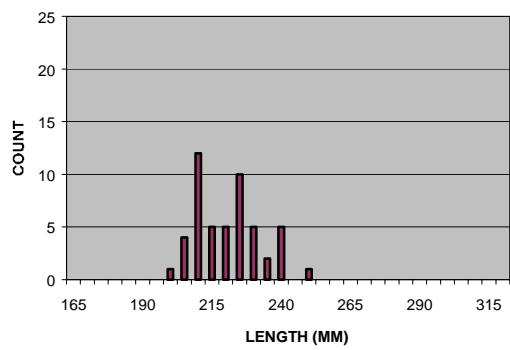
TRIP 22: WGOM SFS



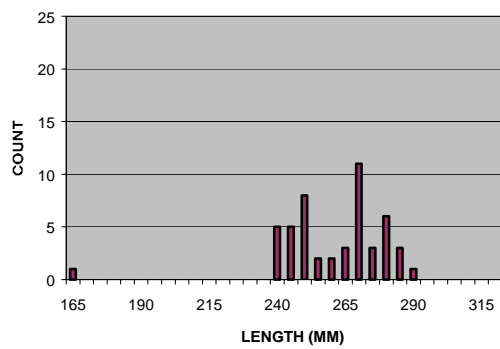
TRIP 23: WGOM SFS



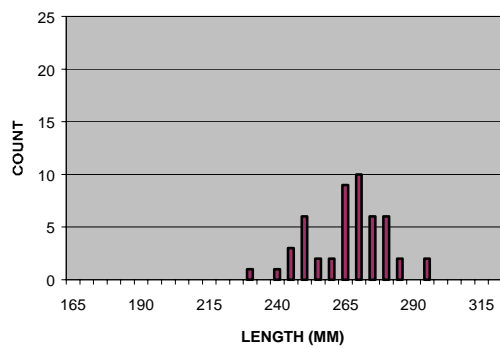
TRIP 24: WGOM SFS



TRIP 25: WGOM SFS

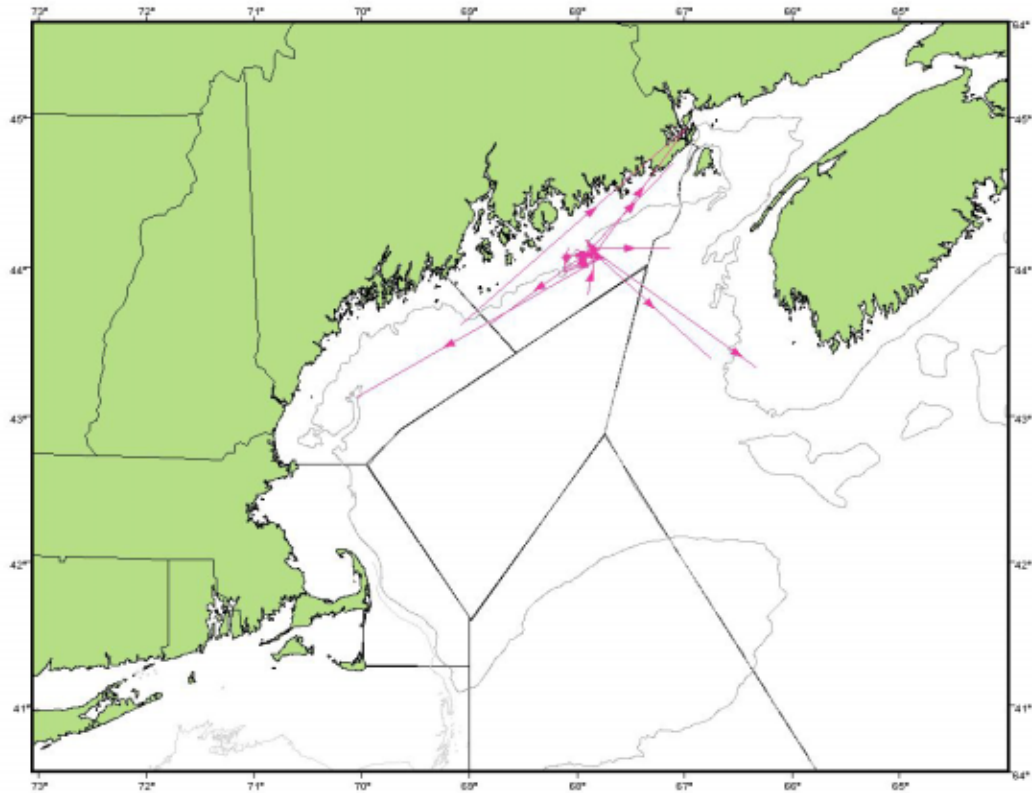


TRIP 26: WGOM SFS

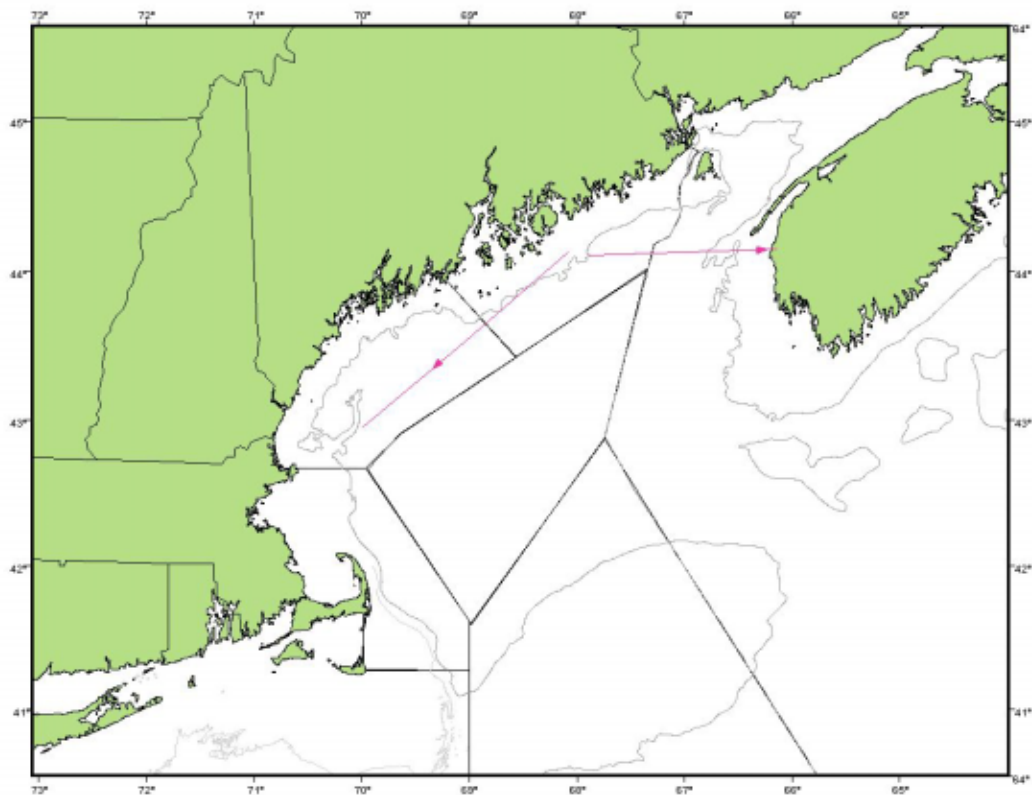


**Appendix 2: Maps illustrating herring movement by temporal return strata**  
(An abbreviation key can be found on the last page of this report)

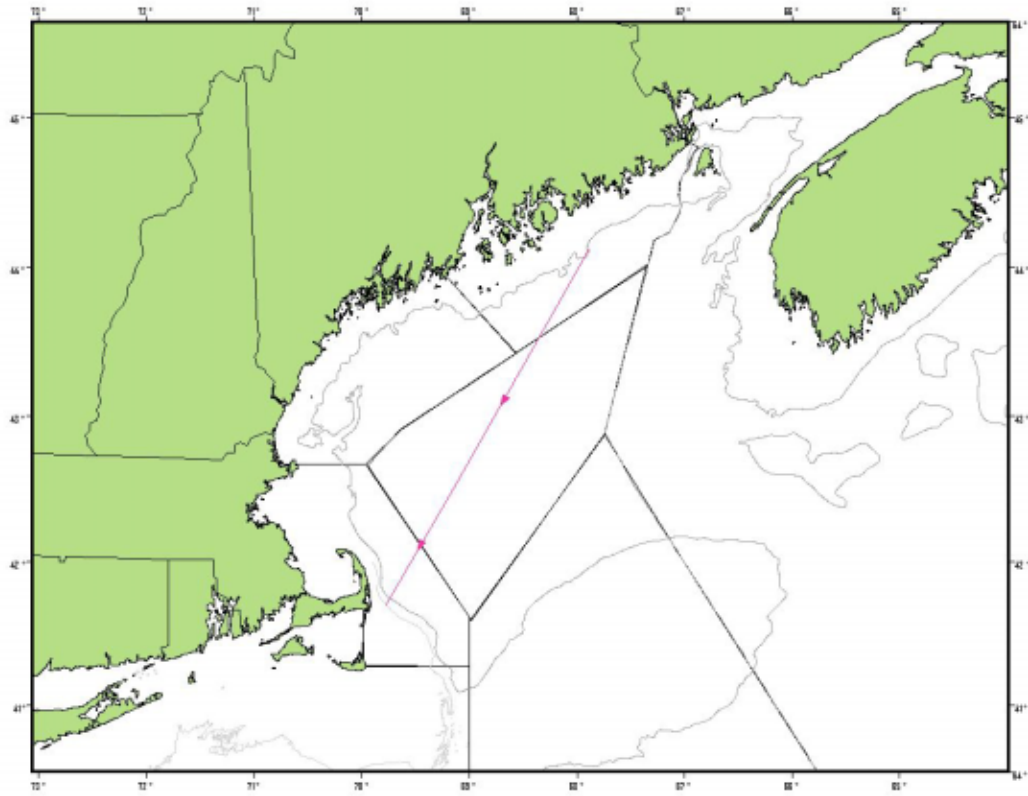
**TAGGED EGOM/SFS – RETURNED SFS**



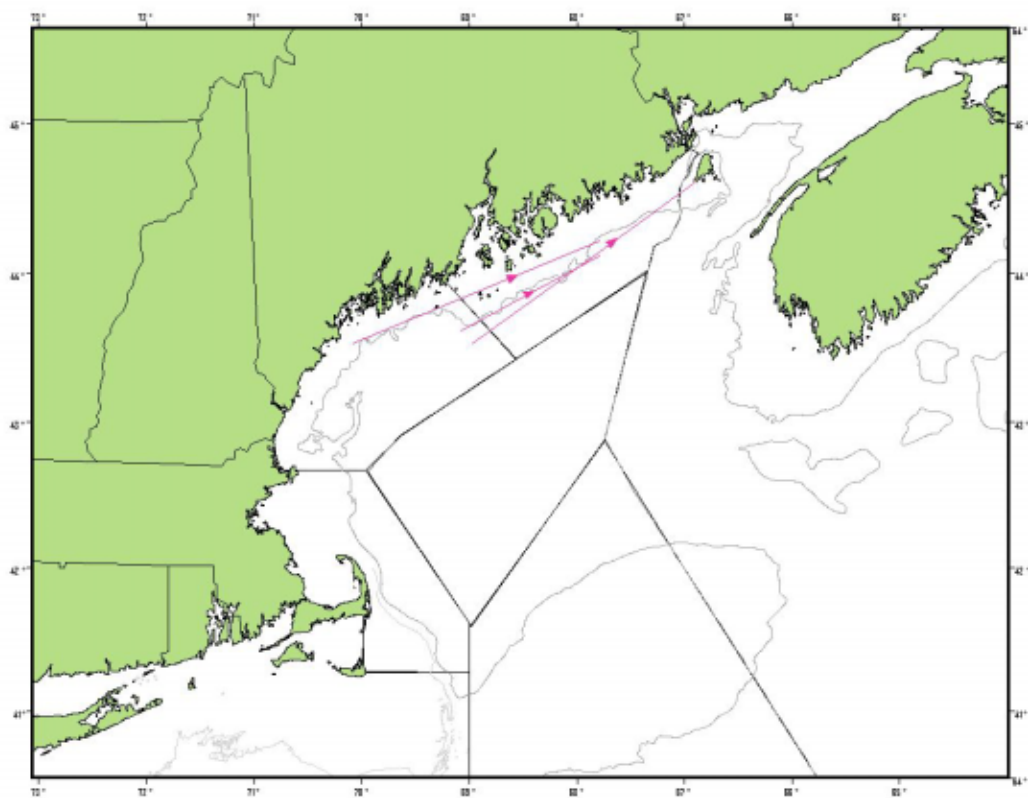
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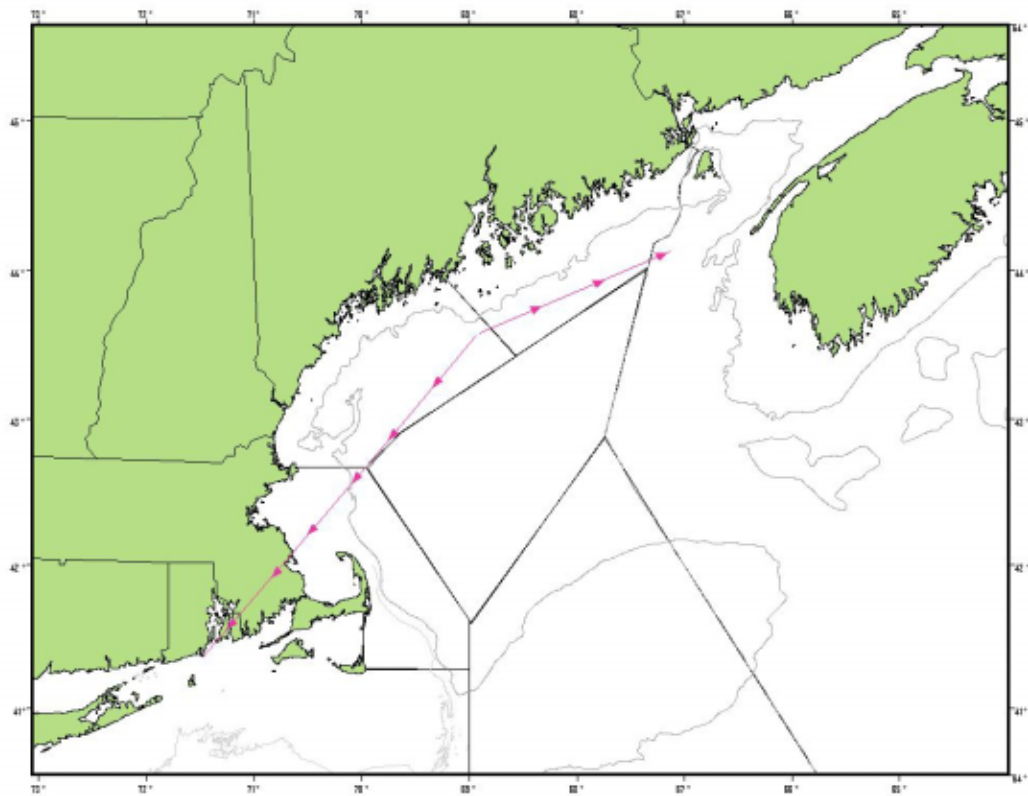
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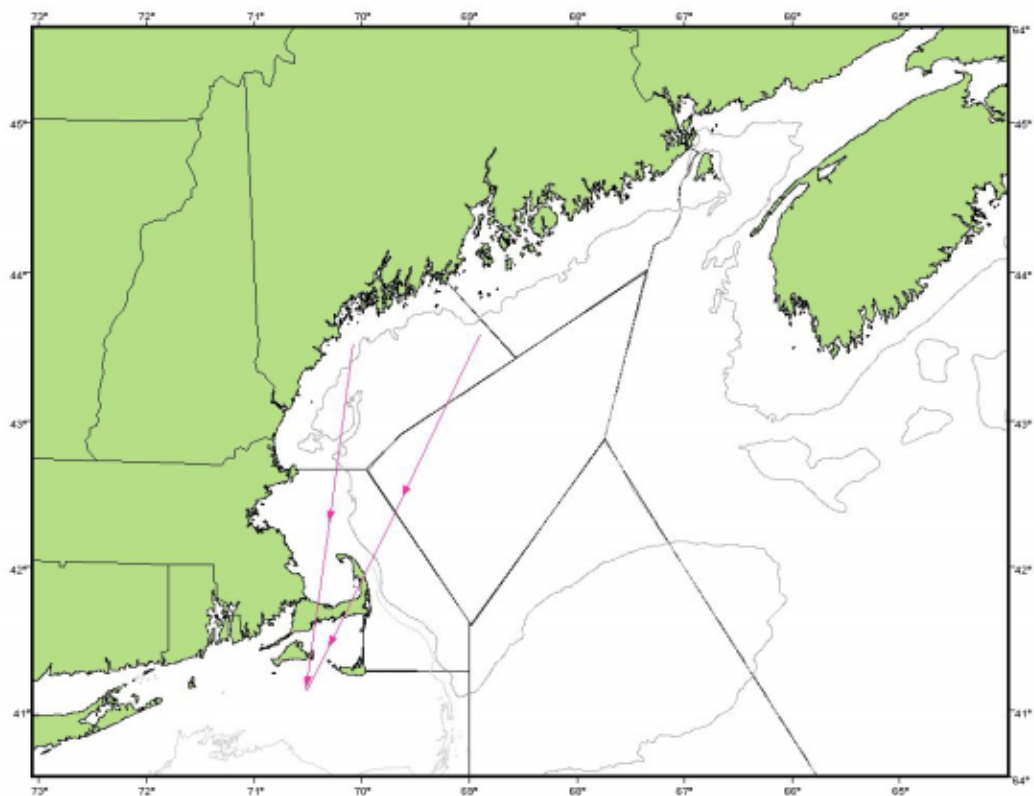
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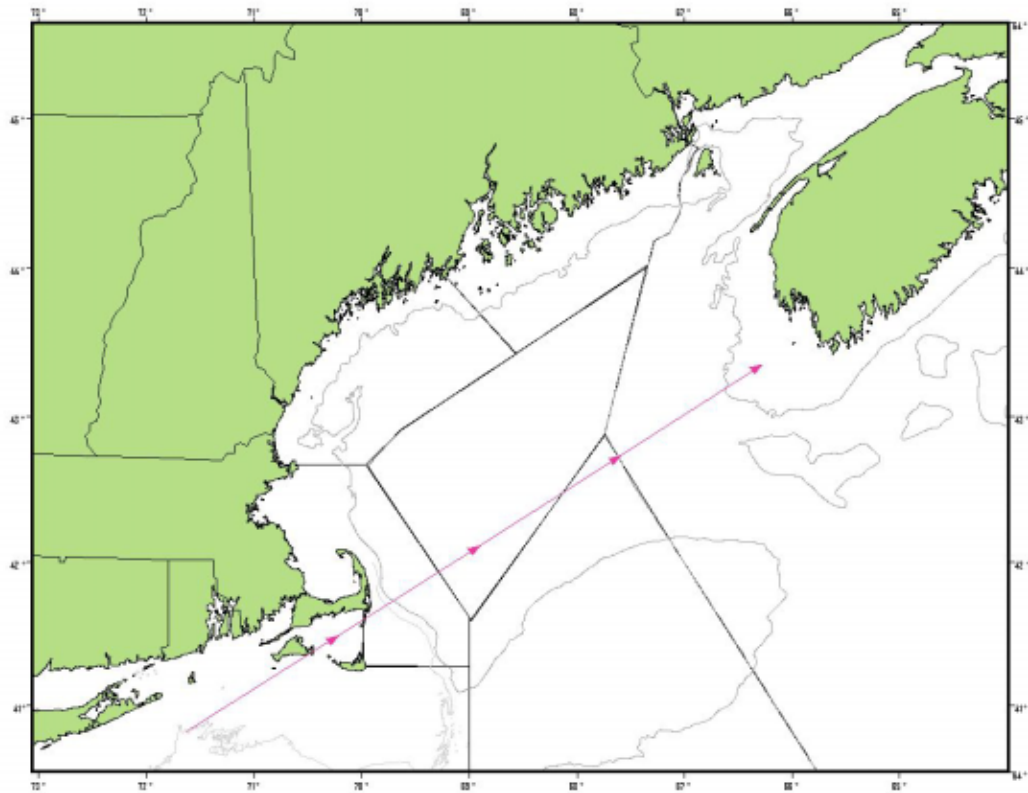
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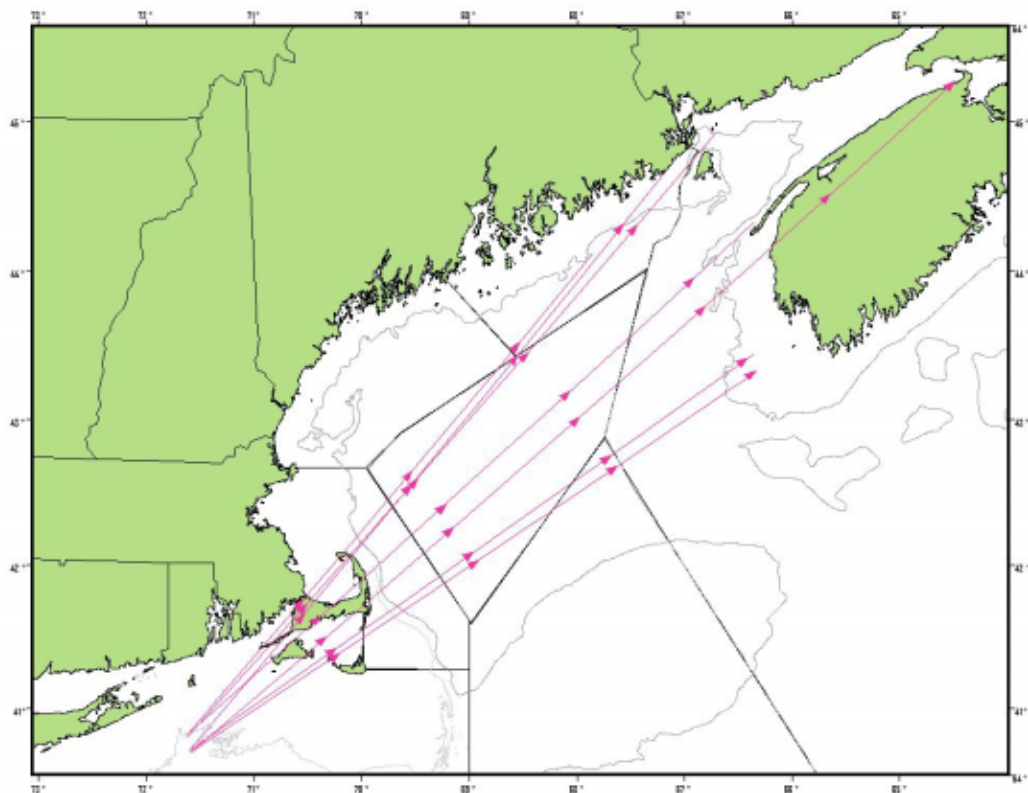
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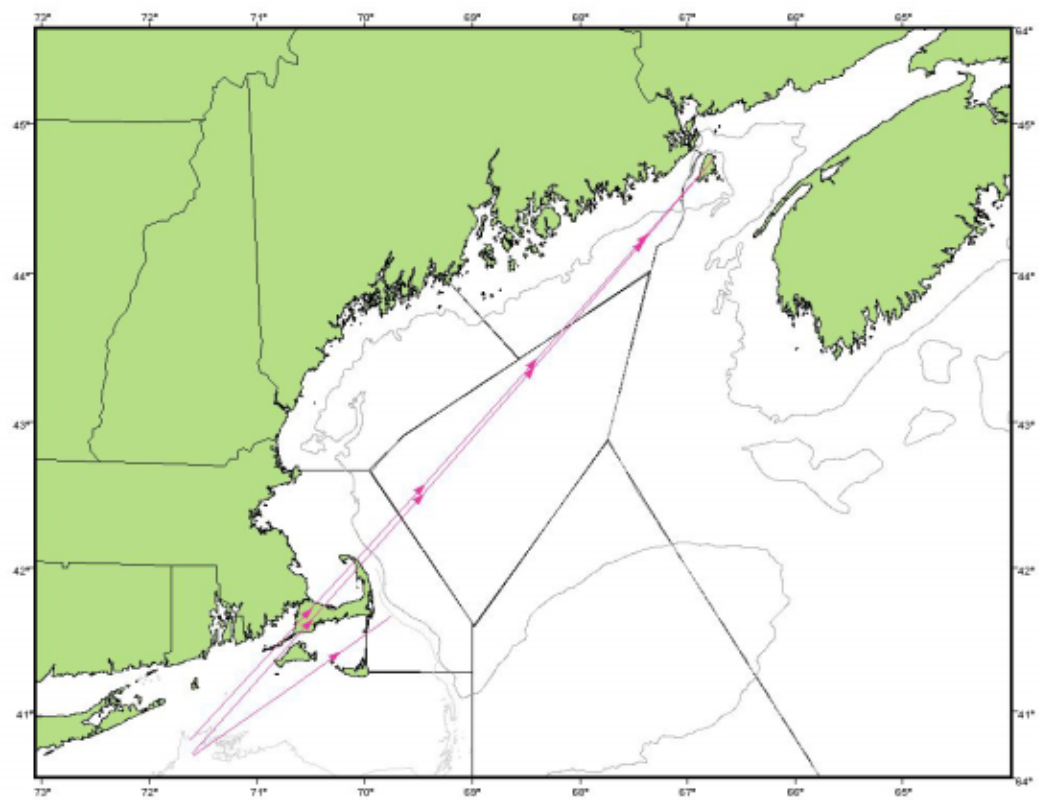
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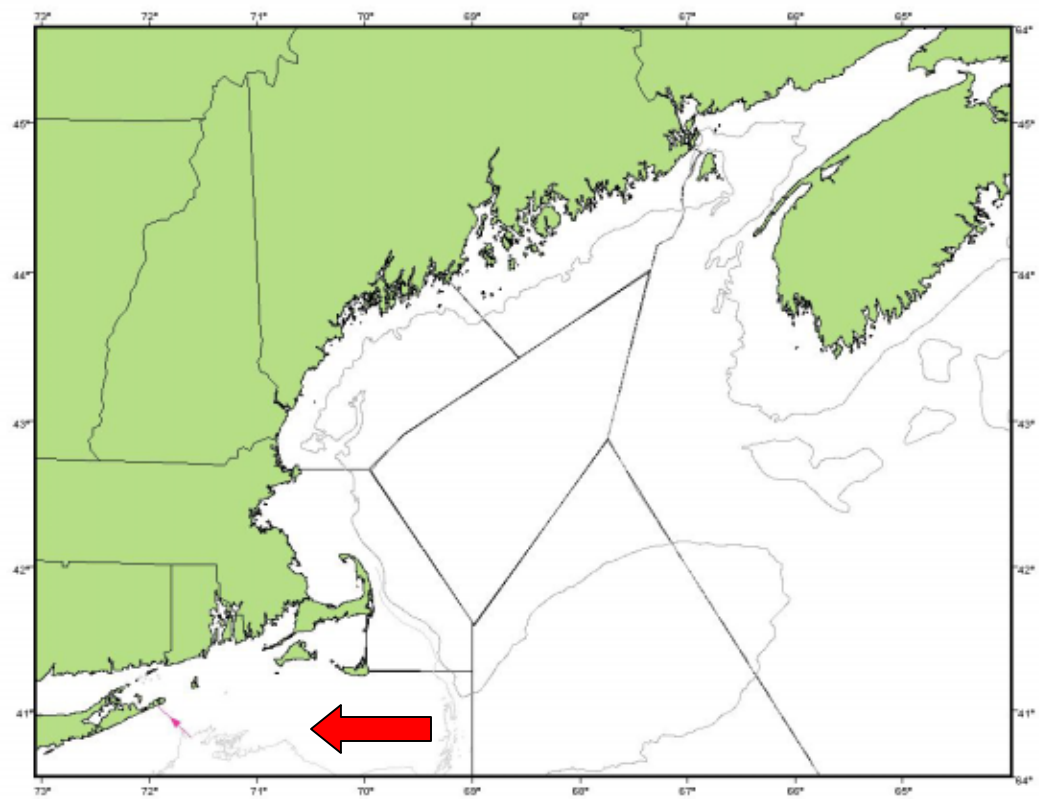
### TAGGED SNE/SM – RETURNED SFS



### TAGGED SNE/SM – RETURNED FM



### TAGGED SNE/SM – RETURNED WF





### Appendix 3: Abbreviations for spatial and temporal strata

SPATIAL STRATA	ABBREVIATION
NEW BRUNSWICK	NB
NOVA SCOTIA	NS
EASTERN GULF OF MAINE	EGOM
WESTERN GULF OF MAINE	WGOM
MASSACHUSETTS	MA
OFFSHORE GULF OF MAINE	OGOM
GEORGES BANK	GB
SOUTHERN NEW ENGLAND	SNE

TEMPORAL STRATA	ABBREVIATION	TIME PERIOD
SPRING MIGRATION	SM	APRIL-JUNE
SUMMER FEEDING/SPAWNING	SFS	JULY-OCTOBER
FALL MIGRATION	FM	NOVEMBER-DECEMBER
WINTER FEEDING	WF	JANUARY-MARCH